

## **A hybrid UMTS/WLAN telecommunication system**

### **Field of the invention**

The present invention relates to the field of telecommunication systems, and more particularly without limitation, to hybrid UMTS/WLAN-type systems. The invention is based on a priority application EP 02 360 285.7 which is hereby incorporated by reference.

### **Background and prior art**

Seamless access to modern office tools is one of the most valuable assets for mobile business professionals today. Most corporate information systems and databases can be accessed remotely through the Internet (IP) backbone, but the high bandwidth demand of typical office applications, such as large e-mail attachment downloading, often exceeds the transmission capacity of cellular networks. Mobile professionals are looking for a public wireless access solution that could cover the demand for data-intensive applications and enable smooth online access to corporate data services.

Wireless standards, such as IEEE 802.11 and Blue Tooth (BT) are designed to enable mobile devices, such as mobile telephones, laptop computers and personal digital assistants (PDAs) to communicate with each other and a wired Local Area Network (LAN).

Such mobile devices are capable of moving between wireless LANs (WLANs), and some mobile devices can roam between different types of wireless networks (e.g., a WLAN and a cellular mobile telecommunications network). Such transfers typically require establishing a new connection with the new WLAN for the mobile device making the transfer.

These technologies provide for a common attachment approach for different devices, and so enables mobile phones, laptops, and PDAs to be easily networked in the office and in public locations. The IEEE 802.11 (Institute of Electrical & Electronics Engineers) and ETSI (European Telecommunications Standards Institute) HIPERLAN/2, provide a

wireless connection function and may be used to support WLAN (wireless LAN) communications.

The IEEE 802.11 Wireless LAN standard focuses on access points on the same subnet. If a mobile device decides to associate itself with a new access point on the same subnet then it uses a series of Associate and Disassociate commands defined within the IEEE 802.11 specification to signal its move from the old to the new access point. If a mobile device transfers to a new subnet, a new secure (WEP) session is typically established between the mobile device and the new access point with a new encryption link.

Some mobile devices also have the capability of moving among different types of wireless communication networks, such as between a WLAN network (Bluetooth or IEEE 802.11, as described above) and a mobile telecommunications network, such as one based on a mobile telephone communication protocol (e.g., CMTS or cellular mobile telephone system, GSM or Global System for Mobile communications, PCS or Personal Communications Services, or UMTS or Universal Mobile Telecommunications System). For example, the mobile device (e.g., laptop computer or PDA) includes communications interfaces (e.g., communications hardware and software) that allow the mobile device to communicate with two (or more) different types of wireless networks. Typically, when the mobile device moves to access a different type of wireless network, the current communication session with the current wireless network terminates, and the mobile device establishes a new communication session (new communication) with the newly accessed wireless network.

To be truly effective, mobile users must be able to move their mobile devices freely from location to location. For example, users must be able to move their mobile devices from the office to their own conference room to the airport lounge to their client's conference room, while maintaining access to the same set of resources without manually registering anew in each location. They should also be able to send and receive messages and voice calls, wherever they are located. Connection servers, such as routers, WLAN gateways, and security servers, should be able to handle a mobile

device that moves its connection to the network from access point to access point, from public to private networks, or from one wireless network system to a different type of wireless network system.

US Patent Application 20020136226 shows a system for enabling seamless roaming of mobile devices among wireless networks. A network gateway manages roaming of a mobile device between heterogenous network systems. The network gateway obtains an access identifier from another heterogenous network system so the mobile device can roam to the other heterogenous network system while maintaining its connection to the home network gateway for the mobile device.

Coupling of WLANs and Public Land Mobile Networks (PLMN) systems can be implemented in different ways. 3GPP defines six stages of coupling with an increasing level of interworking.

The scenarios range from Open Coupling (level 1, basically constituting two separate access systems with common billing only) over Loose Coupling (level 2 and 3, additionally common Authentication, Authorization, and Accounting (AAA) services) to Tight (level 4 and 5) and Very Tight Coupling (level 5 and 6). Several field trials currently are implementing and testing the Open and Loose approach.

Further an approach for tight coupling has been suggested wherein the access points of the WLAN are directly coupled to the SGSN of the core network by means of an interworking unit (IWU). To date the prior art is silent regarding approaches for very tight coupling.

It is therefore an object of the present invention to provide for an improved interface unit / interworking unit enabling very tight coupling of 3GPP/UMTS and WLAN-type systems. Further the invention aims to provide a corresponding hybrid telecommunication system and telecommunication method.

## **Summary of the invention**

The underlying objects of the present invention are solved basically by applying the features laid down in the respective independent claims. Preferred embodiments of the invention are given in the dependent claims.

In accordance with the present invention an interface or interworking unit (IWU) is coupled to the radio network controller (RNC) of a 3GPP/UMTS-type system.

The radio network controller (RNC) is a logical node in the radio network sub-system (RNS) which is in charge of controlling the use and the integrity of the radio resources. It is the purpose of a RNC to be connected to one or more Node Bs. A Node B is a logical node in the RNS responsible for radio transmission/reception in one or more cells to/from the user equipment.

In accordance with the present invention, an IWU is connected to the RNC instead of a Node B. From the perspective of the RNC the IWU mimics the functionality of a Node B. From the perspective of the WLAN the IWU is coupled to one or more access points (APs). The IWU converts the communication protocols which are used for communication between Node B and RNC and which are used between the APs in order to couple the WLAN to the 3GPP/UMTS telecommunication systems. For the purpose of the radio network control functionality the IWU collects data describing the load situation of the access points of the WLAN. This load situation is reported from the IWU to the RNC.

In accordance with a preferred embodiment of the invention, the IWU converts transportation of user data and control data via ATM or IP to transportation via Ethernet and vice versa. For example, the IWU is connected by a short distance Ethernet bus to a plurality of APs of the WLAN. On the other side the IWU is connected to the RNC via a long distance ATM connection.

In accordance with a further preferred embodiment of the invention the physical cells within the WLAN constituted by the APs are grouped into logical cells, where each logical cell can comprise a number of physical cells.

It is preferred that the IWU handles the load balancing of the APs within a logical cell locally without involving the RNC. In this instance the IWU only reports data being descriptive of the load situation with respect to the logical cells but not with respect to individual physical cells. In accordance with a further preferred embodiment of the invention the RNC handles handover control between the logical cells of the WLAN but not between the physical cells within the logical cells. This is analogous to the handling of handovers between the cells of a 3GPP/UMTS network.

### **Brief description of the drawings**

In the following preferred embodiments of the invention will be described in greater detail by making reference to the drawings in which:

Figure 1 is a block diagram of a preferred embodiment of a hybrid telecommunication system of the invention,

Figure 2 is a block diagram of a more detailed second embodiment of a hybrid telecommunication system of the invention,

Figure 3 is illustrative of a user plane protocol stack for very tight coupling,

Figure 4 is illustrative of a control plane protocol stack for very tight coupling,

Figure 5 shows a block diagram of a further preferred embodiment of a hybrid telecommunication system of the invention.

### **Detailed description of preferred embodiments**

Figure 1 shows a block diagram of a hybrid telecommunication system. One or more RNCs 100 are coupled to core network 102.

A number of Node Bs 104 is coupled to RNC 100. Each of the Node Bs 104 provides one or more cells 106. This way a 3GPP/UMTS-type telecommunication system is provided.

Further, an interface or interworking unit (IWU) 108 is coupled to RNC 100. From the perspective of RNC 100 IWU 108 mimics a Node B. Further, IWU 108 is coupled to access points (APs) 110 of a Wireless Local Area Network (WLAN). Preferably the WLAN is a HIPERLAN type 2 as specified in ETSI; HIPERLAN Type 2; Data Link Control (DLC) Layer; Part 2: Radio Link Control (RLC) sublayer; TS 101 761-2 V1.3.1 (2002-01), the entirety of which is herein incorporated by reference, or an IEEE 802.11 WLAN system.

The IWU 108 collects load information from the access points 110 and provides the load information to the RNC 100. This enables the RNC 100 to provide radio network control functionality with respect to the WLAN in the same or a similar manner like for the cells 106 of the 3GPP/UMTS telecommunication system.

Figure 2 shows a more detailed block diagram of a preferred embodiment. In this embodiment RNC 200 is connected to core network 202 and to one or more Node Bs 204. Further RNC 200 is connected to one or more IWUs 208. The link between RNC 200 and Node B 204 is a long distance connection, such as e.g. an ATM or IP link. Likewise the connection between the RNC 200 and IWU 208 is of the same ATM or IP long distance type.

IWU 208 is connected to APs 210 of the WLAN by means of bus 212. Preferably bus 212 is an Ethernet bus. Each of the APs 210 communicates with one or more wireless terminals (WT) 214.

For coupling of the WLAN to the 3GPP/UMTS telecommunication systems the IWU 208 has a converter functionality between the ATM and the Ethernet transport layers. This way the IWU 208 can communicate with the APs 210 and with the RNC 200. By converting the messages from the WLAN protocol stack (transported via, e.g., Ethernet) to/from the APs 210 into messages from the UMTS protocol stack (transported via, e.g., ATM or IP) to/from the RNC the IWU 208 mimics a Node B 204 to the RNC 200.

To enable a seamless handover in the case of a UMTS-to-WLAN or WLAN-to-UMTS transition of a WT 214 all WLAN data and control information should be mapped to UMTS logical channels. The required protocol stacks can be based on the approach to

use the IP layer provided by the WLAN network to transport UMTS MAC-d and MAC-c/sh PDUs. Based on this approach, each WLAN system offering the possibility to transport IP traffic can be used for this Very Tight Coupling approach.

A protocol stack for the user plane is depicted in Fig.3 for the case of a dual mode UMTS/WLAN WT by way of example. For details of the individual UMTS protocol entities reference is made to 3GPP (TSG RAN), TS 25.401 V3.8.0: "UTRAN Overall Description (Release 99)", Sept. 2001. Above the UDP layer the normal UMTS stack is applied, i.e., the architecture is completely transparent, the IP-tunnelling mechanism (PDCP, GTP-U) between the terminal and the CN is not affected.

For a dual mode terminal equipped with a WLAN and a UMTS air interface both protocol stacks below the MAC-d layer are shown in Fig.3 and Fig.4. The WLAN air interface is used as an equivalent alternative of the UMTS air interface. The choice of either type is done within the depicted selection entity, whereas the control of the selection entity is done by the UMTS RRC and/or UMTS MM. There may also be WTs only equipped with a WLAN air interface; in this case the selection entity and the UMTS air interface specific layers below shall be omitted. The frame protocol (FP) between the RNC and the Node B, which in UMTS is necessary for the multiplexing of the MAC PDU is removed. Instead the individual IP connections between the RNC and the IWU are used for this functionality. The corresponding control plane for the "intelligent IWU" approach is depicted in Fig.4.

The generation and the analysis of the load report between the IWU and RNC is processed within the 'IWU Control' layer. The NWAP protocol (Node-W Application Part, an extended UMTS NBAP protocol) can be used as a transport function as illustrated in Fig. 4. The load report represents the total load of the overall 'WLAN-UMTS radio cell', but there is still the possibility that the traffic inside a 'WLAN-UMTS radio cell' is not distributed homogeneously, e.g., a huge number of WLAN WTs communicate via one AP while other APs serve only a few WTs. In this case the IWU has to distribute the load by means of a forced handover within the 'WLAN-UMTS radio cell'.

This function is included in the WLAN RRC layer. The IWU also supports the handling of the complementary handover strategies of UMTS and WLAN systems: Within UMTS the handover is controlled by the RNC for all CS and PS services transported in the DCHs. In contrast, the handover decision algorithm in WLAN terminals is completely independent from the WLAN AP, i.e. the AP is not involved, a WLAN terminal contacts without any control of the WLAN network the selected new AP. To resolve this situation the following concept is suggested as a preferred embodiment:

- The RNC shall not have any control with respect to handover inside a "WLAN-UMTS radio cell", i.e. horizontal handover.
- If a WLAN terminal moves from one "UMTS-WLAN radio cell" to another controlled by the same or another IWU the RNC is involved.
- Each vertical handover is controlled by the RNC, i.e., the RNC informs the IWU that a dual mode terminal will leave or enter the 'UMTS-WLAN radio cell'.

Figure 5 shows a block diagram of further preferred embodiment. The telecommunication system of figure 5 has a core network 302 to which one or more RNCs 300 are connected. RNC 300 has common radio resource management (CRRM) 312, UMTS handover control 314 and WLAN handover control 316. It is to be noted that WLAN handover control 316 is an optional component for RNC 300, especially for WLANs which do not allow handovers which are initiated by the wireless terminal (WT).

RNC 300 is connected at least to interworking unit (IWU) 308 which has a WLAN handover control 318. Further IWUs 308 can be connected to the RNC 300 as well as one or more Node Bs.

WLAN has a number of APs 310. Each of the APs 310 is connected to IWU 308 by a bus connection, such as an Ethernet bus connection. Each of the APs 310 covers a certain geographical region which defines the boundaries of a physical cell 320. A plurality of neighbouring physical cells 320 constitutes a logical cell 322. Preferably the logical cells 322 appear as the smallest level of granularity from the perspective of the RNC 300.

The common radio resource management (CRRM) 312 requires that a load report from each of the logical cells 322 is provided to the RNC 300. The generation of this load report is based on a two step approach:

The IWU 308 gathers information from each AP 310, summarizes these individual reports and transfers the result to the CRRM 312 in the RNC 300. Preferably the following information is included in the report:

Topology/configuration changes (e.g., "on the fly" installation or removal of APs 310 from the WLAN), impact on resources of terminal handovers between the logical cells 322, changes of radio conditions and resulting changes of available resources. For this purpose an extended NBAP protocol, i.e. the NWAP protocol is used to transmit this information, while the IWU 308 control is responsible for the processing of the information.

In other words, the IWU 308 collects data from the APs 310 concerning the load condition of each individual AP 310. Based on this information the IWU 308 determines the overall load situation for each one of the logical cells 322. The overall load situation expresses the total load of the APs 310 within the cell 322 as a fraction of the integrated capacities of all physical cells 320 within that logical cell 322. Data descriptive of this overall load situation of each one of the logical cells 322 is provided from the interworking unit (IWU) 308 to the CRRM 312 within RNC 300 for the purpose of management of the radio resources.

As the overall load report which is provided from the IWU 308 to the CRRM 312 describes the total load within a logical cell 322, there is the possibility that the traffic inside the logical cell 322 is not distributed homogeneously. For example, such a situation occurs when the majority of the WTs 324 within logical cell 322 is concentrated within one of the physical cells 320 of logical cell 322 while other physical cells 320 of the same logical cell 322 have no or few WTs 324.

In such a situation IWU 308 can redistribute the load within the logical cell 322 by means of its WLAN handover control 318. By issuing appropriate control signals forced handovers of WTs 324 within the physical cell 320 of logical cell 322 which is densely populated are initiated in order to free capacity of the densely populated

physical cell 320. Such a forced handover within a logical cell 322 is illustrated in the upper logical cell 322 of figure 5.

It is to be noted that such a forced handover within the logical cell 322 is entirely handled on the level of IWU 308 without involving the RNC 300. However, if a WLAN is used which does not allow the individual WTs 324 to initiate handovers, the handover control can also be handled on the level of RNC 300, and more specifically by WLAN handover control 316.

If a WT 324 moves from one logical cell 322 to another logical cell 322 the handover is controlled by the RNC 300 rather than by the IWU 308 as this situation is analogous to a handover which occurs in the UMTS network when a user equipment (UE) is moved from one cell to another cell.

In summary handover situations are preferably handled as follows:

- Handover between a logical cell 322 of the WLAN and a cell of the UMTS network: Such a handover situation is controlled by the RNC 300. The IWU 308 is informed that a WT 324 leaves or enters a logical cell 322.
- Forced handover between logical cells 322 of WLAN: This is handled by the RNC 300.
- Forced handover between physical cells 320 within the same logical cell 322: This is initiated and controlled by the APs 310 within the logical cell 322 and/or by the IWU 308, and particularly by WLAN handover control 318.
- Handover based on WLAN principle (initiated by WT 324): The new AP 310 of the WT 324 has to inform the IWU 308 about the new WT 324. In response the IWU 308 has to send an updated load report to the RNC 300.

## List of Reference Numerals

---

100	radio network controller (RNC)
102	core network
104	Node B
106	cell
108	interworking unit (IWU)
110	access point (AP)
200	radio network controller (RNC)
202	core network
204	Node B
208	interworking unit (IWU)
210	access point (AP)
212	bus
214	wireless terminal (WT)
300	radio network controller (RNC)
302	core network
308	interworking unit (IWU)
310	access point (AP)
312	common radio resource management (CRRM)
314	UMTS handover control
316	WLAN handover control
318	WLAN handover control
320	physical cell
322	logical cell
324	wireless terminal (WT)